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PRODUCTION OF NAVAL STORES

BY NAVAL STORES RESEARCH DIVISION, BUREAU OF AGRICULTURAL CHEMISTRY AND ENGINEERING

CONTENTS

	Page		Page
Introduction	1	Products using naval stores	7
Definitions	2	Uses of turpentine	7
Collecting the gum	2	Uses of rosin	7
Processing	5	Gum provides income for many	8

INTRODUCTION

Travelers on the railroads and highways of certain sections of the Southern States are impressed by the sight, curious to many, of thousands of white-faced pine trees having receptacles of metal or of baked clay, like flowerpots, fastened at the base of those long white faces. These trees are the production plants of pine oleoresin, which is the raw material for the naval stores industry, one of the oldest of American industries, and, at present, one of the more important industries of that section of the South extending along the Atlantic Coastal Plain and the Gulf coast from North Carolina through South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and into eastern Texas. Naval stores are no longer primarily supplies for the Navy, but the term is a survival from the days when wooden ships sailed the seas and the crude oleoresin which exuded from the living southern yellow pine was used to make oakum to calk the seams of those vessels, to treat the ships' rope, and even to plait the hair of the "jolly jack-tars." Because of this close association with the sea, the products of the gum were referred to as naval stores, along with other ships' supplies obtainable from the ship chandler.

The wooden sailing vessel has given way to the steel steamship, and the ship chandler to the boilermaker and machinist and the wholesale grocer. The term "naval stores" has clung to but one group of products—turpentine and rosin—and in a broad sense, to the resinous, tarry, and oily products of the southern pine. The recovered volatile portion of pine gum, the gum spirits of turpentine of today, was used in early days, as now, to thin paints.

Two of the several pines of the South are the commercial source of naval stores; these are the longleaf pine (*Pinus palustris Miller*) and the slash pine (*P. caribaea Morelet*). Not only is the living tree a source of naval stores but the resinified stumps and "lightwood"—the resinous wood remaining after the sapwood has rotted off—also

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yield naval stores products. This latter group is classed as wood naval stores. About 65 percent of the naval stores production in the United States is from the living tree, and is referred to as gum naval stores; the other 35 percent is wood naval stores obtained by one of the several methods to be described later.

The United States produces more than half of the world's supply of naval stores. Other important producing countries are France, Russia, Portugal, India, Spain, and Mexico. Normally, about 50 percent of the United States production of naval stores is exported, with the United Kingdom the largest foreign consumer.

DEFINITIONS

The various naval stores products have been defined and classified according to methods of production in the Federal Naval Stores Act as follows:

(1) *Gum spirits of turpentine.*—The designation "gum spirits of turpentine" shall refer to the kind of spirits of turpentine obtained by distillation of the oleorosin (gum) from living trees, and commonly known prior to the passage of the act as gum spirits, gum turpentine, spirits of turpentine, or oil of turpentine.

(2) *Steam-distilled wood turpentine.*—The designation "steam-distilled wood turpentine" shall refer to the kind of spirits of turpentine obtained by steam distillation from the oleoresinous component of wood whether in the presence of the wood or after extraction from the wood, and commonly known prior to the passage of the act as wood turpentine, steam distilled turpentine, steam distilled wood turpentine, or S. D. wood turpentine.

(3) *Destructively distilled wood turpentine.*—The designation "destructively distilled wood turpentine" shall refer to the kind of spirits of turpentine prepared from the distillate obtained in the destructive distillation (carbonization) of wood, and commonly known prior to the passage of the act as destructively distilled wood turpentine or D. D. wood turpentine.

(4) *Sulphate wood turpentine.*—The designation "sulphate wood turpentine" shall refer to the kind of spirits of turpentine prepared from the condensates that are recovered in the sulphate process of cooking wood pulp, and commonly known as sulphate turpentine or sulphate wood turpentine.

The definition for rosin given in the Naval Stores Act is as follows:

Rosin is the vitreous, well-strained, transparent product, consisting chiefly of noncrystallized resin acids that remain after the removal of the volatile oil from the oleoresinous secretions obtained from species of the family Pinaceae, or that are present in the wood thereof, and contain relatively small proportions of resin esters or other esters, nonacid and noncrystalline resenes, or nonresinous foreign matter.

Rosin within the meaning of the act consists of gum rosin or wood rosin.

(*a*) "Gum rosin" is rosin remaining after the distillation of gum spirits of turpentine from the oleoresin (gum) obtained from living trees.

(*b*) "Wood rosin" is rosin recovered after the distillation of the volatile oil from the oleoresin within or extracted from pine wood, by any suitable chemical or physical process, followed by any necessary further refinement.

COLLECTING THE GUM

The naval stores producing season starts on April 1 and ends the following March 31. Briefly, the method of producing crude pine gum, the source of gum turpentine and gum rosin, consists in periodically—usually at weekly intervals—cutting through some of the inner

bark of the tree with a sharp cutting tool having a U-shaped blade, known as a hack. The procedure is known as chipping (fig. 1). Each wound produced in chipping is in the shape of a letter V and is known as a streak. The first streak is made as low as is convenient and each new streak is made just above the last one. The combined streaks constitute what is known as a face on the tree. The operator cuts about 32 streaks in each face being worked during the gum-flowing season (April to October). Ten thousand faces constitute a "crop," the working unit of the industry. A clean cut through the inner bark allows the clear oleoresin to flow from the resin ducts that have been

FIGURE 1.—Chipping. (Photograph by the U. S. Forest Service.)

severed. It is believed that such wounding also actually stimulates oleoresin production by the tree. The oleoresin or gum, known to the trade as "dip," flows over the face to one or two pieces of sheet metal (galvanized iron or aluminum), called an apron or gutter so placed and shaped as to guide the gum into the collecting receptacle called the cup. The cup may be shaped somewhat like a flowerpot or like a long narrow pan and may be made of clay, galvanized iron, aluminum, or glass. The capacity of most cups is about 3 pints.

The cups fill up with gum about once a month or after about every four chippings. They are then emptied or "dipped" (fig. 2) into buckets which in turn are emptied into barrels, usually wooden, and hauled to the distillery, or "still." As the oleoresin flows over the tree face to the cup some of it adheres and thickens causing an accumulation of comparatively dry resinous material on the face. This material, called scrape, is removed (fig. 3), usually at the end of each season, by scraping and is processed like gum.

FIGURE 2.—Dipping.

FIGURE 3.—Scraping. (Photograph by the U. S. Forest Service.)

PROCESSING

The pine gum, which is essentially a solution of resin acids in turpentine, is usually processed without preliminary cleaning, in copper-pot stills supported and partly enclosed by brickwork and heated directly by wood fires. The procedure is simple, consisting merely in distilling off the spirits of turpentine and water in the gum, aided by the addition of water. The turpentine and water vapors are condensed in a coiled copper pipe, called a worm, which passes through a "tub" of water and empties into a separator. The two liquids, being practically insoluble in one another, separate rapidly into two layers, the turpentine on top. By means of automatic devices, water is drawn off continuously from the bottom and turpentine from the top, of the separator. Often the turpentine is passed through a simple so-called dehydrator containing rock salt to remove any water which was not removed by the separator. After coming from the separator or the dehydrator, the gum turpentine, a colorless, limpid, aromatic liquid, is run into barrels or tank cars for shipment, or into large storage tanks.

There remains in the still a molten mixture of modified resin acids and resenes known as rosin, together with some needles, bits of bark, sand and chips which have escaped removal by skimming during an interruption of the stilling. The foreign material, after the rosin runs from the still, is removed by passing the molten rosin through a series of wire strainers, and finally through layers of cotton batting supported on a wire screen. The rosin, still molten, is run into packages—wooden barrels, metal drums, tank cars, or even multiple-ply paper bags.

No matter how carefully this simple method of producing gum turpentine and rosin is carried out, there is a wide variation in the properties of the products, particularly the rosin. Moreover, no matter how carefully the straining is done there are always some very fine particles which cannot be held back by the cotton batting. Studies have shown that in order to produce a rosin free of all foreign matter it is necessary to filter the gum and then to wash it. Such a process, generally referred to as gum cleaning, is now in operation in several plants throughout the naval stores belt.

Usually for each barrel (50 gallons) of turpentine, 3⅓ "round" barrels of rosin, each weighing approximately 500 pounds gross, are produced. Turpentine is quoted by the gage gallon, and the conversion factor used is based upon an assumption that 1 gallon weighs 7.2 pounds at 70° F. Formerly, rosin was sold in 280-pound units called commercial barrels. The use of this unit, like many other practices in this industry, dates from colonial days when rosin was shipped in rived-stave barrels. The buyer recognized a tare of 20 percent, or 56 pounds, on a barrel having a gross weight of 280 pounds. This left 224 pounds net which was 2 English hundredweights or a tenth of the English long ton. Recently the unit for rosin quotations has been changed to 100 pounds net, with most rosin now being packed in metal drums having a uniform tare weight.

As previously stated, resinous stumps and lightwood, also called down wood, are the raw materials for the second group of pine prod-

ucts, known as wood naval stores. This group is in turn subdivided into steam-solvent, and destructively distilled products, depending upon the method of production. To this list should be added sulfate wood turpentine byproduct in the production of sulfate pulp. In the steam-solvent process, the stumps are hogged, or ground, and placed in heated digesters. Live steam is introduced and the more volatile components are carried off and condensed; later, they are refined by fractional distillation into steam-distilled wood turpentine and pine oil. The residual shredded resinous wood is treated with a mineral oil solvent which dissolves the rosin and the high-boiling liquid products. The solution is clarified and the solvent is evaporated, leaving a residue of wood rosin. The extracted wood is used as fuel or to make paper pulp. A variation of the steam-solvent process consists of first extracting the turpentine, rosin, and pine oil with a suitable solvent and then separating these products by fractional distillation with steam.

In the destructive-distillation process, the stumps and branches are loaded into steel cars which are run into retorts; after sealing the retort to prevent entrance of air, heat is applied and the volatile products from decomposition of the wood and resinous material are condensed. This process yields destructively distilled wood turpentine, tars, tar oils, rosin pitch, and charcoal. Some of the products are further fractionated to yield chemical products used in pharmaceuticals and as disinfectants.

Sulfate wood turpentine is recovered by condensing the vapors released from the pulping digesters in the production of pulp from pine wood by the sulfate process of making paper. The crude byproduct is heavily contaminated with sulfur compounds which are removed by chemical treatment and fractional distillation; the refined byproduct is marketed as sulfate wood turpentine. The spent cooking liquor obtained in this method of making paper pulp, commonly called black liquor, is treated to recover a mixture of fatty and resin acids known as talloel or liquid rosin.

The kind and age of cup, the age of face, care in distillation, and amount of trash in the gum all help to determine the color of the rosin that will be produced. The colors range from a very pale-yellow through shades of amber and brownish red to nearly black. Since color is an important consideration in some of the industrial uses for rosin, color classes or grades have been established and a letter or abbreviation is used to designate each grade. The palest of the American grades is X, with WW, WG, N, M, K, I, H, G, F, E, D, and B following, the last, B, being an extremely dark brown-red, nearly black. The first three are symbols for the descriptive names, "extra," "water white," and "window glass," which are used in speaking of these grades. Also, in order to avoid possible misunderstanding of the spoken letters, especially M and N, names beginning with the respective letters have been commonly used for other grades. These are Nancy, Mary, Kate, Isaac, Harry, George, Frank, Edward, Dolly, and Betsy. With the exception of an additional FF grade established solely for wood rosin, the same grades apply to both gum and wood rosins.

PRODUCTS USING NAVAL STORES

In general, for most uses gum and wood products are interchangeable. The wide variety of products into the production of which turpentine and rosin enter is shown by the following lists of uses:

Uses of Turpentine

- Thinner for paints and varnishes
- Solvent for resins in lacquers and varnishes
- In wood fillers
- In wood stains
- Solvent for waterproofing compounds
- Solvent for rubber (caoutchouc) and similar substances
- Production of—
  - Synthetic camphor
  - Synthetic resins
  - Terpinene
  - Terpinolene
  - Terpin hydrate
- Pharmaceuticals, including—
  - Disinfectants
  - Liniments
  - Medicated soaps
  - Salves
  - Haarlem oil
- As a mild fumigant
- In polishes:
  - Paste shoe polish
  - Furniture polish
  - Linoleum polish
  - Wax auto polish
  - Floor polish
  - Stove polish
  - Copper polish
  - Liquid floor wax
- Ingredient in cements:
  - Metal cement
  - Leather cement
  - Rubber cement
  - Laboratory cement for gastight joints
- In insecticides
- In some printing inks
- In modeling and grafting waxes
- Stain remover
- In tree insect bands
- In stove enamels
- In indelible laundry marking ink
- In drawing crayons
- Lubricant in grinding and drilling glass
- In ceramic work for application of colors
- Bleaching of bones for buttons, etc.
- In laundry glosses
- In washing preparations

Uses of Rosin

- Manufacture of—
  - Laundry soaps and soap powders
  - Sizing for paper, paperboard, wallboard
  - Ester gum and other synthetic resins
  - Paint driers (resinates of lead, manganese, cobalt, and other metals; Japan driers)
  - Gloss oils
  - Flat wall paints
  - Antifouling paints
  - Varnishes and lacquers
  - Lacquer for food containers
  - Axle greases
  - Waterproofing compounds (insoluble rosin soaps)
  - Enamels used in ceramics (resinates of heavy metals)
  - Sealing waxes
  - Shoemaker's wax
  - Grafting wax for trees
  - Sticky flypaper
  - Tree insect bands
  - Coating for adhesive tape
  - Belting adhesive
  - Adhesive for wigs
  - Matches
  - The cheaper linoleums and oilcloths
- Manufacture of—Continued.
  - Venice turpentine substitute
  - Munitions (matrix in shrapnel cases)
  - Fireworks
  - Slushing oils for protection against rust
- As an ingredient in—
  - Cements:
    - Optical-grinding holder
    - Shoe-repairing cements
    - Roofing cements
    - Aquarium cements
    - Metal-to-glass cements
    - Glass-to-glass cements
    - Silk-to-rubber cements
    - Rubber-to-glass cements
    - Vulcanized rubber cements
    - Handle cements
    - Battery seals
    - For coating wire
    - For coating nails
  - Plastic wood
  - Papier mâché
  - Belt dressings
  - Wood preservatives
  - Marking crayons
  - Disinfectants as adhesive
  - Sheep dip

As an ingredient in—Continued.
- Boiler compounds
- Stove enamels
- Waterproofing compounds for paper, fabrics, woods
- Electrical insulating compounds
- Expansion-joint filler
- Roofing materials
- Insect powders

On violin bows
To remove hog bristles
To remove poultry pinfeathers
As solder flux
As filler on brush backs
For pipe bending
Rosin soap as an emulsifier in asphalt
To impregnate sawdust for fire starters
For setting bristles in hair brushes
In wax tapers
To harden tallow candles
In boxing and wrestling rings
Hot-spot cement
Pharmaceutical purposes:
- Ointments
- Plasters
- Cerates
- Internal remedies (veterinary)
- Disinfecting compounds

In destructive distillation to produce—
- Rosin oils used in—
  - Cements
  - Lubricants (oil and axle grease)
  - Gash and sealing cement
  - Belt dressings
  - Printing inks
  - Adulterating linseed oil
  - Brewer's pitch
  - Varnishes
  - Rubber substitutes
  - Funnel paints for yachts
  - Flotation concentration of ore

In destructive distillation to produce—Continued.
- Rosin oils used in—Continued.
  - Mixtures to protect trees from climbing insects
  - Shingle stains
  - Waterproofing textiles and cordage
  - Manufacture of lampblack for lithographic purposes
  - Soapmaking
  - Leather dressings and shoe polishes
  - Sweeping compounds
  - Latex adhesive
- Rosin spirits used in—
  - Illuminants
  - Turpentine substitutes
  - Cheap varnishes
- Acetic acid used for making—
  - Acetate of lime (source of acetone)
  - Acetate of iron (mordant and mineral dye)
  - Acetate of alumina (waterproofing cloth)
- Pitch, used for—
  - Cobbler's wax
  - Preserving cordage and nets
  - Roofing felts and waterproof papers
  - Bituminous paints
  - Binder in briquettes
  - Calking ships
  - Cements, lutes
  - Electrical insulations (dry batteries, wiring, etc.)
  - Plastics for patternmaking
  - Grafting wax for trees
  - Paving materials
  - Steel-hardening compositions
  - Waterproof masonry

GUM PROVIDES INCOME FOR MANY

Of the approximately 50,000,000 acres of forest lands in the naval stores region of the South, about 30,000,000 produce naval stores. Nearly 400,000 people in the Naval Stores Belt depend largely, if not entirely, upon the naval stores industry for their living. With the advent of central gum-distilling plants (figs. 4 and 5), many owners of land on which there are small stands of southern yellow pine are finding a new source of cash income in the sale of the crude oleoresin. This supplementary income which corresponds to the "butter and egg money" received by many small farmers in other parts of the country is offering new hope to a large number of small farmers in the South.

The annual production of gum turpentine has varied widely from a peak of 750,000 barrels in the 1908–09 season to a low of 340,000 in 1918–19, with an annual average for 37 years of 551,000 barrels. Production figures for the three seasons, 1937–38, 1938–39, and 1939–40 are 518,454, 534,291, and 382,781 barrels, respectively. A recent sur-

FIGURE 4.—Gum naval stores plant—fire still.

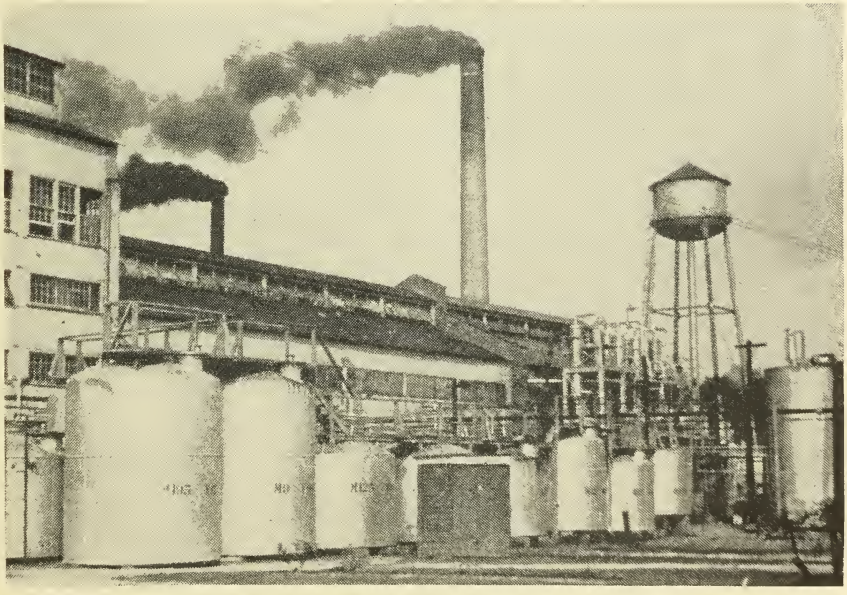

FIGURE 5.—Steam-solvent wood naval stores plant.

vey by the United States Forest Service indicated that this country can produce annually, on a sustained yield basis, 800,000 barrels of gum turpentine and nearly 3,000,000 barrels of gum rosin. The current annual yield of wood turpentine is about 250,000 barrels, and of wood rosin about 1,000,000 barrels.

Detailed information on naval stores woods operations and on timber production and utilization in connection with the production of gum naval stores, may be obtained from the Forest Service, United States Department of Agriculture, Washington, D. C. Further information on methods of collecting and processing pine gum and on uses of naval stores products may be obtained from the Naval Stores Research Division, Bureau of Agricultural Chemistry and Engineering, United States Department of Agriculture, Washington, D. C.

To assure purchasers of pure and properly graded turpentine and rosin the Federal Naval Stores Act establishing standards and providing restrictions on marketing practices is administered by the Department of Agriculture. Copies of the act and regulations can be secured from the Agricultural Marketing Service of the Department of Agriculture.

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